Chapter 3

Pre-Project Site Assessment

During the early planning stages of any project, a thorough site assessment can provide valuable information for planning the layout of site improvements. Developing a site layout considering storm water management to the extent feasible can provide substantial reductions in cost and improve the effectiveness of the project's storm water control measures. Consideration of terrain, required buffer areas, and other natural features can lead to efficient location of BMPs. Additionally, a site layout that keeps clean flows separated from contaminated flows can reduce the need for, and size of, downstream treatment controls. To the extent feasible, projects can be configured to direct storm water runoff from impervious surfaces to landscaped or natural areas, rather than to convey it directly to a discharge location, which may require a structural BMP.

3.1 Site Assessment

A careful evaluation of a site's pre-developed condition is key to minimizing the impacts of development.
Photo Credit – Placer County

A site assessment must be completed for all Regulated Projects and considered for Small Projects during the earliest stages of project planning to appropriately plan the site layout for the capture and treatment of storm water runoff. The incorporation of storm water features is more effective, and often less costly, when site conditions such as soils, vegetation, and drainage characteristics are considered when determining the placement of buildings, paved areas, drainage facilities and other improvements. Site assessments consist of collecting and evaluating data from a variety of sources including, but not limited to, surveys, topographic maps, geotechnical investigations, groundwater records, and site-specific measurements and field observations. The site assessment should evaluate the following key site characteristics:

- Soil, Geologic, and Groundwater Characteristics;
- Topography, Hydrology, and Drainage Characteristics;
- Existing Vegetation and Natural Areas;

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- Contaminated Soil or Groundwater;
- Existing Improvements and Easements; and.
- Opportunities and constraints for preserving or enhancing existing natural resources.

The subsections below provide reference information and guidance for evaluating each key site characteristics and incorporating the results into the layout of improvements and the development of a site plan.

3.1.1 Soil, Geologic, and Groundwater Characteristics

Soil and geologic characteristics and information are necessary for determining the feasibility of infiltrating storm water runoff on a site and will assist in identifying appropriate locations for proposed improvements and the required storm water management measures. Where feasible, buildings, pavement, and other impervious surfaces should be located in areas where soils have lower infiltration rates while infiltration facilities should be installed in more permeable soil areas where there is an average separation of 10 feet between the bottom elevation of the infiltrating BMP and the groundwater surface elevation. At no time shall the separation between the bottom elevation of the infiltrating BMP and the seasonal high groundwater surface elevation be less than 5 feet.

Some information regarding soil types and their potential suitability for infiltrating storm water can be obtained from the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Web Soil Survey (WSS) at the following website:

http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

Soils are categorized into one of four Hydrologic Soil Groups (HSGs) A, B, C or D based on their capacity to percolate water. Type A soils are well drained and highly permeable, while Type D soils consist of low permeability materials such as clays that infiltrate water very slowly. A soils map illustrating the HSGs and their general locations in West Placer region is provided in Figure 3-1. As shown, much of the region's soils are classified as Types C and D indicating high clay content with slow to very slow infiltration rates. Although not ideal for infiltration, LID measures can still be implemented effectively on sites with HSG C and D soils as long as these constraints are considered during the design process. Ideally, site designs allow infiltration to occur to the maximum extent that the native soil will accept and allow for the safe bypass of overflows. In some cases, native soils can be amended to increase their storage and infiltration capacity by mixing organic mulches and/or sandy materials with the less permeable native soils. Additional information on the use of soil amendments is provided in the Fact Sheet SDM-2 in Appendix B.

The WSS provides planning level information such as soil type, HSG, typical infiltration rates, saturated hydraulic conductivity, typical depth to restrictive layers, and typical

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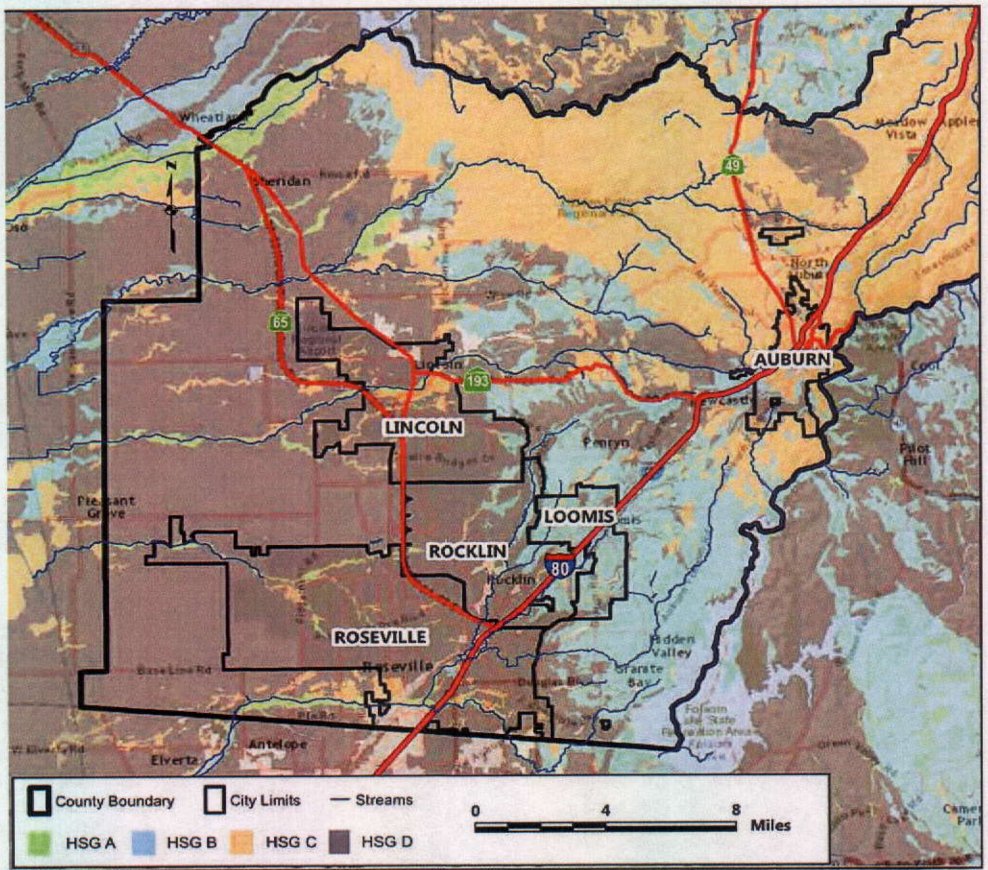
depth to groundwater. The Placer County Stormwater Management Manual[1] (SWMM) (Placer County, 1994) provides additional guidance in determining soil infiltration rates based on the HSG and the type and condition of ground cover. This information may be used for pre-project runoff calculations, but a site-specific geotechnical evaluation is recommended to obtain more accurate soil characteristics and infiltration rates for the design of infiltration facilities. It should be noted that saturated hydraulic conductivity can be used for designing infiltration facilities, but a site specific infiltration rate measurement of soils underlying the infiltration facilities is strongly recommended for final design.



DATA DISCLAIMER:
The features on this map were prepared for geographic purposes only and are not intended to illustrate legal boundaries or supercede local ordinances.
Official information concerning the features depicted on this map should be obtained from recorded documents and local governing agencies.
Hydrologic Soil Group (HSG) information provided by NRCS.

Figure 3-1
NRCS Hydrologic Soil Groups

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[1] The Placer County Stormwater Management Manual is available for download at:

http://www.placer.ca.gov/~/media/dpw/flood%20control/documents/Swmm2004.pdf

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POROUS PAVEMENTS

Fact Sheet SDM-5

Also known as: Pervious pavement and permeable pavement.

DESCRIPTION


Pemeable pavement. Source: EPA

Porous Pavement is a system comprised of a load-bearing, durable surface coupled with an underlying drainage layer that temporarily stores water prior to inlt raon o r drainage to a controlled outlet. The surface can be porous such that water inltr ates across the enr e surface of the material, or it can be constructed of impermeable blocks separated by spaces and joints, through which the water can drain. There are many types of porous pavement including pervious concrete and asphalt, modular block, reinforced grass, cobblestone block, and gravel.

Porous pavement is well-suited for low trac roadways, parking lots, walking paths, sidewalks, playgrounds, plazas, tennis courts, and other similar uses. It has been widely applied in retrot situa ons wher e exisng s tandard pavements are replaced. Porous pavements should not be used in industrial and commercial applicaons wher e pavement areas are used for material storage or the potenal f or surface clogging is increased due to high trac of c onstrucon v ehicles.

ADVANTAGES

- Reduces peak o w rates and total runo v olumes.
- Signic ant o w a enuaon and impr ovement in water quality.
- Can replace exisng pa vements eliminang the need f or addional land.
- Roof runo c an be piped into the subsurface storage area directly, which would increase the level of o w a enuaon.
- Somemes mor e ar acv e than tradional pa vement.
- Reduces size of downstream BMPs.

LIMITATIONS

- Can become clogged if improperly installed or maintained and may require replacement.
- Use should be limited level areas such as parking lots and other lightly track ed or non-track ed areas.
- Not suitable for areas of slope instability where inltr ated stormwater may cause failure.
- Not suitable in locaons tha t can negav ely impact building foundaon or f oongs.
- Not suitable for sites with high concentraons of oil & gr ease or potenal spills.
- Not suitable in industrial and commercial applicaons wher e pavement areas are used for material storage or high trac of c onstrucon v ehicles.
- High groundwater may slow inltr aon, cr eate standing water in the subsurface storage layers and destabilize pavement and/or result in seepage to the surface.

POROUS PAVEMENTS

Fact Sheet SDM-5

KEY DESIGN FEATURES

Source: NACTO

There are several types of porous pavement available, including pervious concrete, pervious asphalt, modular block, reinforced grass, cobblestone block, and gravel. The applicability of each porous pavement type should be carefully evaluated based on land uses and site characteriscs. F or detailed informaon and design guidance on all porous pavement types, refer to the Stormwater Quality Design Manual for the Sacramento Region. General sing and design r ecommendaons f or all porous pavement are as follows:

- Consult a geotechnical engineer to determine what types of porous pavement are suitable for the expected trac load, speed, and volume.
- Consult a geotechnical engineer to determine set back from building, or use 10 feet.
- Determine site soil type and permeability before selecng por ous pavement as a runo r educon s trategy.
- Porous pavements are generally not suitable for sloped areas. Low points should be carefully evaluated and underdrains must placed appropriately to avoid ooding.
- May be used over soils with low permeability in selected situaons if under drain is provided.
- Underdrains should e in to an open landscape area or treatment control measure to quickly relieve the water pressure in the pavement secon and pr olong the pavement life.
- Access ports should be provided for underdrain systems to allow for roune inspecon and cleaning.
- Address seasonal shrink/swell in sites with expansive subgrade. Use the expansion index test (ASTM D4828) to provide insight as to degree of surface deformaon in choosing pa ving secons.
- Consider opportunies f or direcng runo fr om impervious surfaces across porous pavement to achieve runo volume reducon cr edits. See the Roo op and Impervious Area Disconnecon F act Sheet included in this manual.
- Select the porous pavement type based on the type of ancipa ted pedestrian trac; mos t types of porous pavement can be designed to be Americans with Disabilies Act (AD A) compliant.
- A water barrier or interceptor drain will be required where porous material abuts regular asphalt/concrete pavement and there is concern about water inltr ang the r egular pavement sub-base. The water barrier should run down the 12-inch deep excavaon and 12 inches under the dr ain rock.
- For manufactured products, check the manufacturer's specic aons f or any addional sing c onsideraons.

SIZING DESIGN GOALS AND REQUIREMENTS

The Post-Construcon St orm Water Quality Plan (SWQP) Form 3-4 should be used to calculate the retenon v olume (V_{ret}) for porous pavement areas. This value is then used to calculate the area of impervious surface treated, and determine if other site design measures are necessary to capture the 85th percenle, 24-hour design s torm for Regulated Projects. The equaon f or determining V_{ret} is as follows:

$$\mathbf{V_{ret} = A_{res} * D_{res} * n_{agg} * C}$$

Where:

V_{ret} = stormwater retenon v olume (^{3});
A_{res} = area of permeable storage reservoir (^{2});
D_{res} = depth of permeable storage reservoir ();
n_{agg} = porosity of aggregate; and
C = eciency f actor

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A site-specific geotechnical investigation should be conducted under the guidance of a licensed geotechnical, soils, or civil engineer and include digging test pits and conducting infiltration rate measurements in locations where infiltration-based BMPs may be located. Test pits will help confirm the types of soils present onsite, identify soil layers that may impede infiltration, and locate the depth to seasonally high groundwater. Testing should be performed at the soil surface as well as the approximate bottom depth of the infiltration BMP to determine appropriate infiltration rates for design. The infiltration measurement methodology must be selected by an appropriately licensed engineer and applied in a manner that adjusts for the relative influence of sidewall flow in the test configuration to the effectiveness of the sidewall flow in the proposed BMP configuration. The potential for long-term degradation of the infiltration rate and the ability to monitor performance and rehabilitate facilities must also be considered. In many cases, the design rate will be no more than one-half of the adjusted measured rate.

The geological assessment must also evaluate a site's susceptibility to landslides. Landslides occur when the stability of a slope changes from a stable to an unstable condition due to natural and/or anthropogenic causes. Soil saturation is a primary cause of landslides, and infiltration should be limited in areas of high landslide risk, especially when downhill structures, roads, and infrastructure are at risk of being damaged. LID design in areas prone to landslides, especially those that utilize infiltration, should be carefully considered and must be prepared by a licensed civil or geotechnical engineer.

3.1.2 Topography, Hydrology, and Drainage Characteristics

Site topography, hydrology, and drainage characteristics are also critical factors in developing an appropriate site layout for LID implementation. Clearing, grading, and building should be avoided on slopes greater than 25 percent, and, as discussed above, steep slopes and landslide-prone areas are not recommended for infiltration facilities. The design of storm water conveyance and treatment measures relies on existing, or constructed, grades to direct runoff to the desired locations and provide adequate hydraulic head (pressure) to drive flows through treatment measures.

The topography of upstream and downstream sites should be considered for any potential contribution to the total runoff generated during a storm event. Designing effective LID into new or existing sites requires a careful analysis of the topography and how and where storm water runoff will concentrate and flow. Site assessment of the pre-developed site during a storm event is highly recommended to observe and map areas of natural infiltration, concentration, flow, and offsite discharge points.

For previously developed sites, record, or as-built, drawings should be reviewed if available. In the event that topographic data does not already exist for the site or the accuracy of available data is inadequate, a professional topographic survey should be performed prior to proceeding with project design. The survey should produce a detailed topographic base map of the site with contour lines for each foot of elevation change. The survey should also identify the location and elevation of any existing improvements, utilities, and storm water structures (e.g. curb and gutter, swales, catch basins, storm drain pipe inverts, outfalls). This base map provides the starting point in the development of the site plan.

Hydrologic and drainage characteristics of the site should be identified and assessed including:

- ***Onsite streams and water bodies***: Streams and water bodies should be delineated for the project site to locate setbacks and buffer zones. The presence and extent of receiving waters, wetlands, environmentally sensitive areas (ESAs), and impaired water bodies on the 303(d) list or with established Total Maximum Daily Loads (TMDLs) should be clearly defined (see the SWRCB website below for identification of pertinent water bodies).

  www.waterboards.ca.gov/water_issues/programs/water_quality_assessment

- ***Floodplains and drainage hazards***: Floodplains on the site should be delineated to identify areas where significant flooding may occur. LID principles may be effectively implemented in floodplains, where allowed by the jurisdictional agency, but the impacts of potential flooding on proposed LID improvements should be assessed. Development within the floodplain should be avoided to the extent practicable. Areas of the site with other potential drainage hazards such as erosion and landslides should also be identified.

- ***Drainage areas, flow paths, and run-on/runoff locations:*** For the pre-project condition, define the area(s) within the site that drain to common discharge location(s). For undeveloped sites, these areas are defined by the natural topography of the site. For previously developed sites, any existing drainage improvements must be considered since they can alter the locations of drainage area boundaries.

  The key characteristics of existing flow paths include locations, direction of flow, and capacity. It is also critical to identify all locations where storm water might enter a site (run-on) and where it discharges from a site.

3.1.3 Existing Vegetation and Natural Areas

LID design strategies include the preservation or enhancing the quality of existing native, and other high quality vegetation to the maximum extent practicable. The designer should identify existing natural and environmentally sensitive areas on the site and consider how these areas can be preserved and integrated into the site design. Avoiding sensitive areas and preserving natural open space may reduce the need for other permits and provides opportunities for reducing the amount of storm water runoff that needs to be treated. Storm water runoff can sometimes be directed to these areas for infiltration and irrigation. Preservation of existing trees and other vegetation that help intercept rainfall and reduces runoff. Where vernal pools are present, it may be necessary to maintain natural runoff quantities to these sensitive areas.

3.1.4 Contaminated Soil or Groundwater

If a site is influenced by contaminated soils and/or groundwater, special consideration of LID design needs to be made. Infiltration of storm water runoff in areas with contaminated soils and/or groundwater should be avoided to prevent mobilization and dispersion of the pollutants. Sites must be reviewed to ascertain if there is a potential that contamination is present. Redevelopment sites must be investigated for underground storage tanks and other potential sources of contamination. If soil and/or groundwater contamination is suspected, LID implementation must avoid further infiltration of storm water runoff and focus on flow-through type treatment devices.

As part of the Preliminary SWQP, the site must be evaluated for the presence of contamination. The SWRCB maintains a database of registered contaminated sites through their Geotracker® program. Sites with soil contamination (brownfields) and former agriculture sites are managed by EPA and the California Department of Toxic Substances Control. For preliminary investigation of site contamination, the websites for these agencies can be accessed as follows:

- SWRCB: http://geotracker.waterboards.ca.gov/
- EPA Brownfield: http://www.epa.gov/brownfields
- California Department of Toxic Substances Control:

  http://www.dtsc.ca.gov/SiteCleanup/Brownfields/

  http://www.dtsc.ca.gov/SiteCleanup/Cortese_List.cfm

3.1.5 Existing Improvements and Easements

Existing improvements from previous on-site development, adjacent properties, public infrastructure, and underground or overhead utilities must be identified and evaluated when planning the site layout. If available, as-built or record drawings should be reviewed and compared to actual site conditions to verify site features such as buildings and structures, parking lots, roads, drainage systems, landscaped areas.

Previously developed sites may have existing underground utilities, including storm water conveyance/detention, sanitary sewers, and/or gas lines, as well as underground or overhead electrical and/or communications lines. Locations of utilities, whether below ground or overhead, must be noted on the site plan so that any conflicts with storm water, or other improvements may be readily identified.

All easement encumbrances for existing or proposed utilities should also be identified and shown on the site plan as they may indicate a future utility, road, or other structure that may conflict with LID features.

Existing improvements and easements can constrain storm water management alternatives.
Photo Credit – Placer County

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Chapter 4

Site Planning and BMP Selection

Selection of an effective set of integrated storm water control measures, or BMPs, can be challenging. Each site is unique, and the application of BMPs will vary depending on site characteristics and proposed use of the site. The storm water management requirements vary depending on the different project categories (i.e., Small, Regulated, Hydromodification Management Projects). This chapter provides a step-wise process for selecting complementary BMPs to complete an effective and integrated design.

This chapter is organized by project categories as described in Chapter 2. Information in the corresponding subsection(s) below provides guidance for selection of BMPs that are appropriate for the site and project type.

4.1 Small Projects

For Small Projects, a site plan showing the layout of improvements and storm water control measures is required to demonstrate consideration of the following:

- Define the development envelope and protected areas, identifying areas that are most suitable for development and areas to be landscaped, or left undisturbed, and used for infiltration. (Sections 3.1.1 through 3.1.4).
- Minimize overall impervious coverage (paving and roofs) of the site.
- Set back development from creeks, wetlands, and riparian habitats in accordance with local ordinances. (Sections 3.1.2 and 3.1.3)
- Preserve significant trees and native vegetation. (Section 3.1.3).
- Conform the site layout along natural landforms. (Section 3.1.2).
- Avoid excessive grading and disturbance of vegetation and soils and stabilize disturbed areas.
- Replicate the site's natural drainage patterns. (Section 3.1.2).

Implementation of one or more Site Design Measure, listed in Table 4-1, is required to reduce project site runoff. The Site Design Measure(s) must be included on the site plan and final improvement plans that are submitted with the building permit application.

Note that some of the Site Design Measures for Small Projects are required to be designed by an appropriately qualified professional engineer licensed in the State of California.

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Fact Sheets in Appendix B provide detailed descriptions and design requirements for each Site Design Measure listed.

Additional guidance for incorporating the required storm water measures into Small Projects is provided in Chapter 6 and the SWQP Template in Appendix A.

Table 4-1 Selection of Site Design Measures for Small Projects[1]

Small Projects must incorporate at least one Site Design Measure	Fact Sheet (Appendix B)	Selection Considerations
Adjacent/On-Site Stream Setbacks and Buffers	SDM-1	Applicable for sites with streams on, or directly adjacent to the property.
Soil Quality Improvement and Maintenance	SDM-2	Consult a qualified professional before using in areas of high groundwater, soil or groundwater contamination, or slopes greater than 10 percent.
Tree Planting and Preservation	SDM-3	Irrigation requirements Defensible space for wildfire
Rooftop and Impervious Area Disconnection	SDM-4	Roof drain discharge must be at least six (6) feet from a basement and at least two (2) feet from a crawl space or structural foundation.
Porous Pavement	SDM-5	Consult a professional engineer before using in areas of high groundwater, soil or groundwater contamination, or slopes greater than 10 percent.
Vegetated Swales	SDM-6	Consult a professional engineer before using in areas of high groundwater, soil or groundwater contamination, or slopes greater than 10 percent.
Rain Barrels and Cisterns	SDM-7	Operation and Maintenance requirements

1. The Phase II MS4 Permit also allows the use of green roofs. This Site Design Measure has been omitted from this Manual as a practice that may not be suitable due to the climate of the region and water conservation requirements. However, project applicants may propose green roofs as a Site Design Measure for consideration on a case-by-case basis.

4.2 Regulated Projects

This section provides guidance for site design considerations and selection and layout of storm water control measures for Regulated Projects. The approach consists of applying information from the site assessment to lay out improvements and BMPs to reduce storm water runoff volumes and pollutant concentrations. This information is intended as a reference source for the development of SWQPs for Regulated Projects which are required to be completed by an appropriately qualified professional engineer licensed in the State of California.

Requirements for Regulated Projects include the following:

- Completing a site assessment to evaluate local conditions and identify LID opportunities and constraints,
- Developing a site layout that incorporates LID storm water management strategies,
- Implementing Site Design Measures to reduce surface runoff by infiltration, evapotranspiration, and/or harvesting and use as close to its source as possible,
- Implementing Storm Water Treatment and Baseline Hydromodification Measures using bioretention-based facilities or facilities of demonstrated equivalent effectiveness,
- Implementing biotreatment/media filters for special case exceptions to bioretention or facility of demonstrated equivalent effectiveness,
- Implementing hydromodification management measures to control post-project runoff rates (required for projects that create or replace more than one (1) acre of impervious surface and result in a net increase in impervious area), and
- Maintaining and implementing an O&M Plan.

For maximum effectiveness, the BMPs listed above should be designed to work together in an integrated system. BMPs can be designed in series to provide multiple treatment steps for pollutant removal and volume reduction. Pretreatment, which refers to design features that provide settling of large particles before storm water enters a storm water treatment facility, is important to ensure proper operation of the facility and reduce the long-term maintenance burden. Perhaps the most common example is a sediment trap placed upstream of another BMP to remove bulk coarse solids in a location that is easily accessed for maintenance upstream from a facility that provides further treatment and runoff reduction. By reducing sediment loads entering a bioretention facility or other infiltration-based facility, pretreatment protects the engineered planting media and/or underlying soil from being occluded prematurely and maintains the infiltration rate of the facility. Another example is installing an oil/water separator upstream of another BMP to remove potential hazardous materials prior to infiltrating runoff. The Phase II MS4 Permit requires that additional treatment steps be considered in high-risk areas such as fueling stations, truck stops, auto repairs, and heavy industrial sites to protect groundwater quality.

The completed SWQP for Regulated Projects provides a multi-layered approach to protect water quality and downstream water bodies. The following sections describe the site planning and BMP selection processes that must be used to develop an effective, integrated SWQP.

4.2.1 Site Plan Layout

The results of the site assessment are used to develop the layout of improvements and site plan, which is submitted with the Preliminary SWQP (see Figure 4-1 for an example). A list with the information required to be included on the site plan is provided in Chapter 6 under the Form 3-4 guidance. The site plan, together with the SWQP, documents consideration of the following items:

- Define the development envelope and protected areas, identifying areas that are most suitable for development and areas to be left undisturbed. (Sections 3.1.2 through 3.1.4)
- Concentrate development on portions of the site with less permeable soils and preserve areas that can promote infiltration. (Section 3.1.1)
- Minimize overall impervious coverage (paving and roofs) of the site.
- Set back development from creeks, wetlands, and riparian habitats in accordance with local ordinances. (Sections 3.1.2 and 3.1.3)
- Preserve significant trees. (Section 3.1.3)
- Conform the site layout along natural landforms. (Section 3.1.2)
- Avoid excessive grading and disturbance of vegetation and soils.
- Replicate the site's natural drainage patterns. (Section 3.1.2)
- Detain and retain runoff throughout the site.

4.2.1.1 Drainage Management Areas

As the proposed new or replaced impervious surfaces are laid out, the associated drainage management areas (DMAs) are defined and identified on the site plan. DMAs are the tributary areas within the project site that drain to a common location where BMPs can be implemented to reduce and treat storm water runoff. DMAs must be carefully defined for each BMP that receive storm water runoff (from both pervious and impervious surfaces) so that they may be appropriately designed. Ideally, DMAs are defined and identified by separating areas that may drain pervious and impervious surfaces. However, depending on the project site grading, it may not be possible to completely separate pervious and impervious surfaces when defining and identifying DMAs. If multiple types of surfaces are present in a DMA, an appropriate composite storm

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water runoff coefficient must be used. The placement of BMPs and identification of DMAs is typically an iterative process as alternative layouts and storm water management strategies are developed.

As described previously, LID storm water management strategy can involve implementation of various BMP combinations in series. Generally, upstream BMPs, or Site Design Measures, are smaller, distributed measures that function to slow and reduce runoff. Downstream BMPs, or Storm Water Treatment and Baseline Hydromodification Measures, function to remove pollutants from the remaining runoff and provide additional runoff flow and volume control. In some cases, DMAs that discharge to separate upstream BMPs must be combined for the design of BMPs located further downstream in the site's drainage system.

The site plan provided in Figure 4-1 presents an example of a new development project consisting of an office building, driveway, and parking lot. The site was separated into four discrete DMAs. DMA 1 consists of the western portion of the office building roof, DMA 2 consists of the eastern portion of the office building roof, DMA 3 consists of a paved driveway, and DMA 4 consists of a paved parking lot.

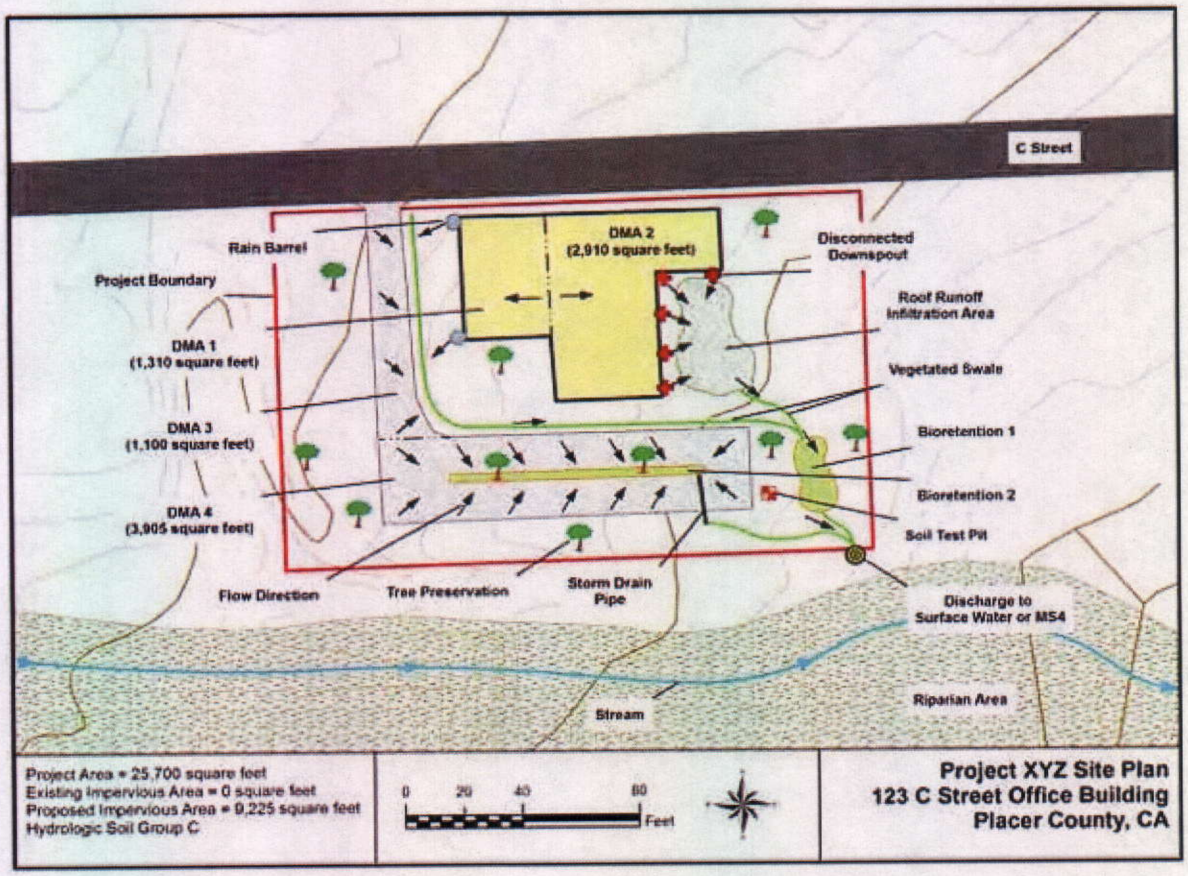

Figure 4-1
Site Plan Example

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Site Design Measures and storm water treatment/baseline hydromodification BMPs (bioretention) to manage runoff from each DMA are also included in Figure 4-1. Roof runoff from DMA 1 discharges to two rain barrels. The rain barrels overflow to a vegetated swale which discharges to a bioretention BMP during larger storm events. Roof downspouts from DMA 2 discharge away from the building to a natural depression where infiltration occurs. The natural depression area overflows into a vegetated swale which conveys runoff to a bioretention BMP. Driveway runoff from DMA 3 slopes towards a vegetated swale which also conveys runoff to a bioretention BMP during larger storm events. In this example, DMAs 1, 2, and 3 all discharge to the same bioretention BMP which would need to be designed to treat flows from all three DMAs. Parking lot runoff from DMA 4 flows to a separate bioretention BMP (parking lot landscaped area) which contains two existing trees to be preserved. Treated storm water and overflow from both bioretention BMPs is combined at a single discharge point and released offsite into the municipal storm drain system or natural drainage way.

4.2.2 Source Control Measures

After properly assessing a site and refining the layout, source control measures are implemented to reduce the potential for storm water runoff and pollutants from coming into contact with one another. The goal of source control measures is to KEEP CLEAN WATER CLEAN.

Source control measures can include both structural and operational measures. Structural source control measures include a physical or structural component for controlling the pollutant source such as installing an efficient irrigation system to prevent overspray and off-site runoff or covering trash enclosures or fuel dispensing operations. Operational source control measures involve practices such as storm water management training, trash management and litter control practices, and general good housekeeping practices. When properly implemented, source control measures are effective in preventing pollutants from entering storm water runoff and are typically less expensive than other types of storm water BMPs.

Regulated Projects with potential pollutant-generating activities and sources are required to implement applicable structural and/or operational source control measures. Selection of source control measures must be based on an assessment of potential pollutant generating activities or sources that are anticipated to occur at the site. Depending on the site operations and activities, typical pollutants of concern that can be mobilized and transported by storm water runoff may include, but are not limited to, microbial pathogens (bacteria and viruses), metals, nutrients, toxic organic compounds, suspended solids/sediment, trash and debris, and oil and grease. Some examples of source control measures include trash enclosures, street or parking lot sweeping, and proper materials storage practices.

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In some areas, downstream water bodies may be impaired, or subject to TMDL requirements (Chapter 3). In these situations, the pollutant(s) of concern must be identified along with any additional actions that may be required to control potential releases of the pollutant(s).

The Source Control Measures Selection Table (Appendix C) shall be used as a guideline to identify and select source control measures for inclusion in the SWQP. In some cases, multiple source control measures will be used in combination. The table does not include all possible pollutant generating project characteristics/activities that may warrant the consideration of source control measures and additional operational or structural source control measures may be required.

The California Stormwater Quality Association (CASQA) Storm Water BMP Handbooks, or an accepted equivalent reference document, provide recommended guidance for design of source control measures. CASQA has published several storm water BMP handbooks for various project applications and settings, and the source control measures identified in Appendix C reference fact sheets in one or more of these handbooks. The identification codes in the table correspond to the CASQA fact sheets which can be referenced for more information on each source control measure. The CASQA Storm Water BMP Handbooks are available for purchase at:

www.casqa.org/resources/bmp-handbooks/

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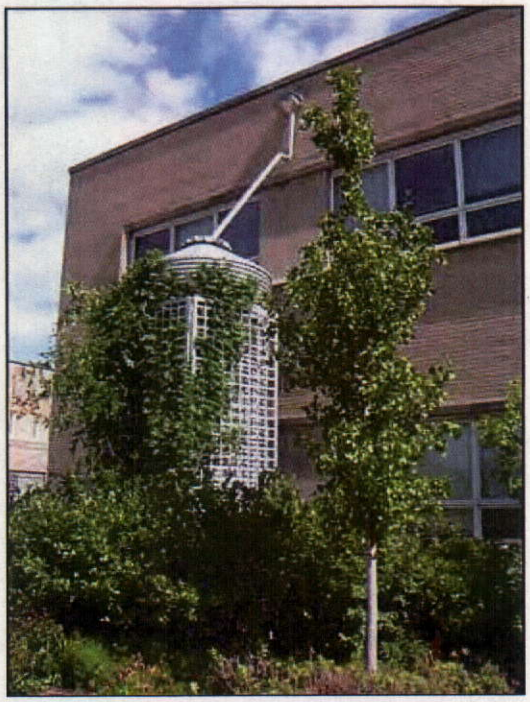
4.2.3 Site Design Measures (LID BMP Selection)



Distributed Site Design Measures, such as this cistern, can provide significant reductions in site runoff.
Photo Credit – U.S. EPA

Site Design Measures are generally small-scale, distributed BMPs that are intended to reduce and treat surface runoff volumes by managing storm water as close to its source as possible. Site Design Measures often incorporate vegetation which can further reduce runoff through evapotranspiration. These storm water controls are critical for maintaining a site's predevelopment hydrology, which is a primary goal of LID.

Regulated Projects are required to incorporate the Site Design Measures listed in Table 4-3 to the extent technically feasible with the objective of retaining the impervious runoff volume generated by the post-construction 85th percentile, 24-hour storm event by means of infiltration, evapotranspiration, and/or harvesting and use. Typical feasibility considerations are included in the table, but technical feasibility can vary based on a wide variety of site specific conditions that must be evaluated and determined by a professional engineer. Technical feasibility also requires approval by the jurisdictional agency.

If Site Design Measures applied are demonstrated to completely treat and retain the impervious runoff from the post-construction 85th percentile, 24-hour storm event, then no additional downstream BMPs are required. This determination is made during the development of the SWQP (Appendix A). The Site Design Measure Fact Sheets (Appendix B) provide detailed descriptions and design requirements for each measure listed in Table 4-2.

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Table 4-2 Selection of Site Design Measures for Regulated Projects[1]

Regulated Projects must incorporate Site Design Measures to the Extent Technically Feasible	Fact Sheet (Appendix B)	Feasibility Considerations
Stream Setbacks and Buffers	SDM-1	▪ Applicable for sites with streams on or directly adjacent to the property.
Soil Quality Improvement and Maintenance	SDM-2	▪ Not suitable in areas of high groundwater, soil or groundwater contamination, or slopes greater than 10 percent.
Tree Planting and Preservation	SDM-3	▪ Irrigation requirements ▪ Defensible space for wildfire
Rooftop and Impervious Area Disconnection	SDM-4	▪ Roof drain discharge must be at least six (6) feet from a basement and at least two (2) feet from a crawl space or structural foundation.
Porous Pavement	SDM-5	▪ Not suitable in areas of high groundwater, soil or groundwater contamination, or slopes greater than 10 percent. ▪ Not ideal for sites with infiltration rates less than 0.5 in/hr. ▪ Not suitable in areas with heavy equipment or traffic loads. ▪ Sediment deposition will cause clogging.
Vegetated Swales	SDM-6	▪ Not suitable in areas of high groundwater, soil or groundwater contamination, or slopes greater than 10 percent.
Rain Barrels and Cisterns	SDM-7	▪ Must be emptied to re-establish storage volume between storm events.

1. The Phase II MS4 Permit also allows the use of green roofs. This Site Design Measure has been omitted from this Manual as a practice that may not be suitable due to the climate of the region and water conservation requirements. However, project applicants may propose green roofs as a Site Design Measure which will be evaluated on a case-by-case basis.

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4.2.4 Storm Water Treatment and Baseline Hydromodification Management

Bioretention can be integrated into a site's landscaping to provide water quality and aesthetic benefits while also reducing project costs.
Photo Credit – Greg Bates

After implementation of Site Design Measures, remaining runoff that is not retained by the Site Design Measures must be directed to storm water treatment/baseline hydromodification facilities sized to manage the remaining portion of the post-construction 85th percentile, 24-hour storm event runoff. These treatment facilities, also known as bioretention facilities, are designed to infiltrate, evapotranspire, and/or bioretain the remaining storm water similar to the LID principles of the Site Design Measures. Depending on site characteristics, infiltrating or non-infiltrating flow-through bioretention facilities are typically used to meet this requirement. Infiltrating systems are preferred, and the use of flow-through systems with impervious liners to prevent infiltration is only permitted in several specific cases. These specific circumstances include shallow groundwater conditions, the existence of underlying groundwater or soil contamination, when infiltration creates the potential for geotechnical hazards, or when the facility is located on an elevated plaza or other structure. Bioretention facilities provide pollutant removal through several mechanisms including sedimentation, filtration, and biological processes. Additionally, they reduce runoff volumes and peak flow rates to mitigate the potential hydromodification effects of development.

The determination of which type of storm water treatment/baseline hydromodification control measure(s) to implement can be made using the following flow chart in Figure 4-2. As shown, infiltrating bioretention BMPs are required in the majority of cases. Once the appropriate storm water treatment BMP(s) is (are) selected, refer to the corresponding Fact Sheet (Appendix B) for further design considerations and allowable variations.

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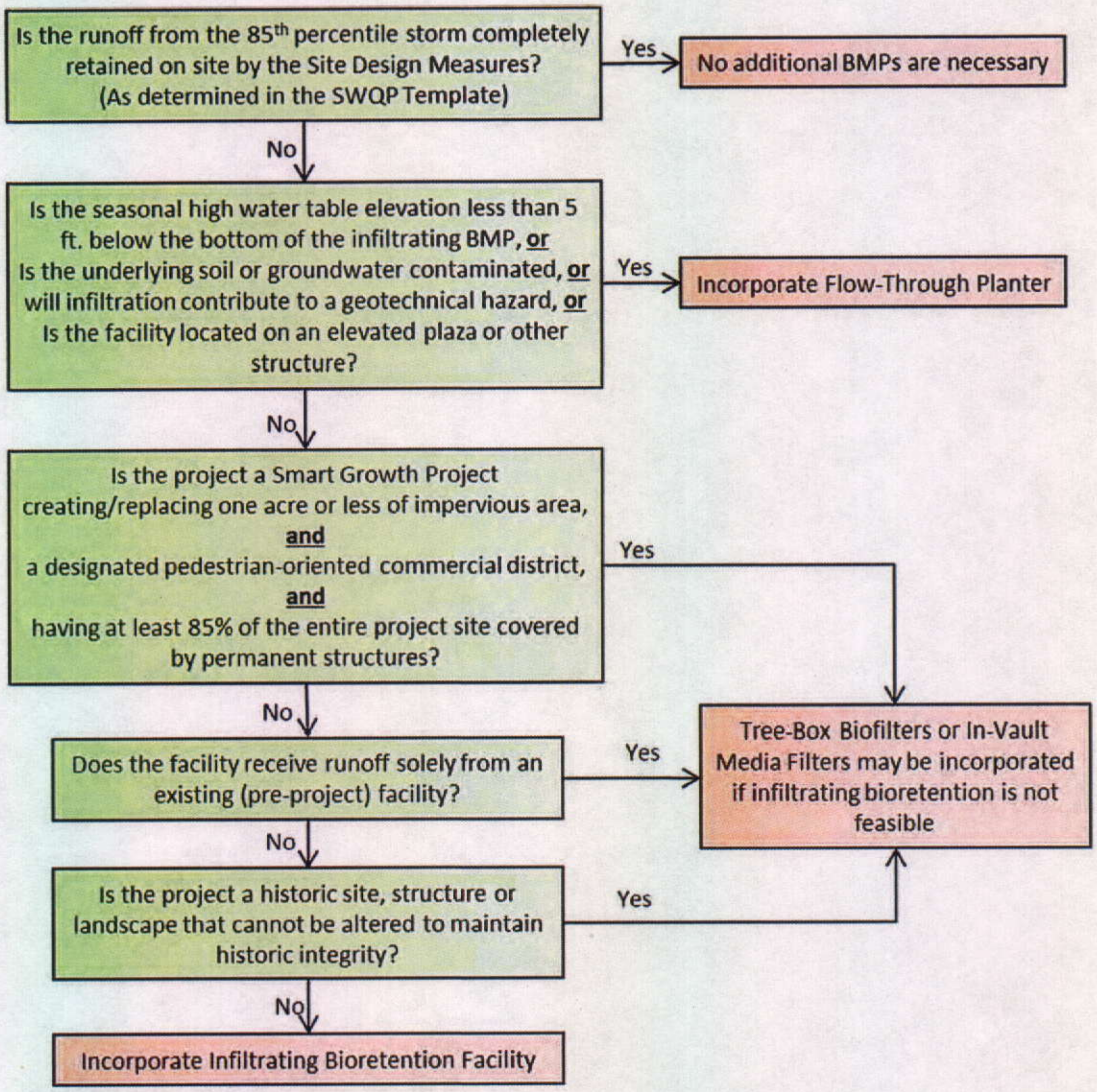

Figure 4-2
Selection of Storm Water Treatment/Baseline Hydromodification Controls

Alternative storm water treatment and baseline hydromodification facilities may be proposed by the designer if the designer can demonstrate that the proposed facility meets all of the following measures of equivalent effectiveness criteria when compared to bioretention facilities:

- Equal or greater amount of storm water runoff infiltrated or evapotranspired for alternatives to infiltrating bioretention facilities
- Equal or greater rate of storm water treatment for flow-through facilities

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- Equal or lower pollutant concentrations in storm water runoff that is discharged after biotreatment
- Equal or greater protection against shock loadings and spills
- Equal or greater accessibility and ease of inspection and maintenance

Proposed alternative storm water treatment and baseline hydromodification facilities will be reviewed on a case-by-case basis by the jurisdictional agency.

4.3 Hydromodification Management Projects

The term "hydromodification" is used to define the changes that occur to the natural hydrologic systems of streams and watersheds and how they have the potential to disrupt the natural balances within the watershed. Hydromodification resulting from land development has the potential to create impacts such as excessive erosion, sediment transport and deposition, stream bed instability, loss of habitat, pollutant loading, and damage to the overall ecosystem in downstream reaches of watershed systems. The dynamics of development projects have historically decreased groundwater recharge, increased runoff volume and peak flow frequencies, and altered the natural hydraulic loading of the receiving water (creek system) hydrology. Most LID principles incorporated into this Manual begin to address and minimize these impacts. In the event that storm water runoff reductions do not meet post-construction condition requirements, as demonstrated with the runoff reduction calculator (made part of the Storm Water Template – Appendix A), additional hydromodification treatment measures are required for Regulated Projects creating and/or replacing one acre or more of impervious surface that create a net increase in impervious surface.

The required performance standard for hydromodification control consists of maintaining post-project runoff at or below pre-project flow rates for the 2-year, 24-hour storm event. If this standard can be achieved through the implementation of Site Design Measures and storm water treatment/baseline hydromodification controls (as referenced in Section 4.2 above), then no further storm water controls are required. If post-construction peak flows do not meet this standard, then additional storage capacity with flow control at the discharge point must be incorporated into the design.

For hydromodification management projects in sensitive environmental locations, and/or larger sized projects with complex hydrologic characteristics, the jurisdictional agency may require an alternative approach to using the template forms. In these cases, additional hydrologic modeling analyses, such as a HEC-1 or HEC-HMS discrete storm analysis, may be required to compare pre- and post-project discharge rates for compliance. In these cases, the Section 4 form should be replaced with model results documentation showing that post-construction runoff is less than or equal to the pre-construction runoff rate for a 2-year, 24-hour storm event.

BMP selection for hydromodification controls should be based on the amount of additional storage needed. Additional storage capacity for hydromodification management can be provided by either increasing the size of the control measures (e.g., Site Design Measures or storm water treatment and baseline hydromodification facilities) that are already incorporated in the design or by adding separate structures such as detention basins or vaults.

Follow the procedures outlined in Chapter 6 and the SWQP Template to determine the additional storage volume needs to select the preferred alternative. If relatively little additional storage is needed, then increasing the capacity of the Site Design and/or storm water treatment measures is likely to be the preferred alternative. For larger additional storage requirements, separate detention facilities are recommended.

4.4 In Lieu Program

Storm water management requirements must be met to the MEP standard as specified in this Manual and within and on the project site. If the storm water management goals specified in this Manual cannot be fully met on the project site due to feasibility constraints, then an In Lieu Project may be identified to satisfy the remaining requirements. All projects that utilize the In Lieu program require review and approval by the CVRWQCB in addition to the jurisdictional agency.

The In Lieu program provides two options:

Option 1- In Lieu Projects

A separate LID, or other environmental protection/enhancement, project may be selected from the list of pre-approved projects developed by the jurisdictional agency, and approved by the CVRWQCB. If an In Lieu Project option is chosen, the jurisdictional agency will identify the In Lieu Project in the Conditions of Approvals to ensure that the requirement is documented in case the property and/or project is sold. The pre-approved list of In Lieu Projects may be amended periodically on a case-by-case basis with approval from both the CVRWQCB and jurisdictional agency.

In Lieu Projects should treat the same type of pollutants that are generated by the untreated portion of the new development or redevelopment project. For example; if the untreated portion of the new development or redevelopment site is roadway, then the In Lieu Project selected should treat runoff from a roadway.

In Lieu Projects should be located within the same jurisdiction or unincorporated area in which the new development or redevelopment project causing the impact is located. Projects located in other areas may be approved on a case-by-case basis. Projects that have the potential to cause a significant impact to a particular water body, as determined by the jurisdictional agency, either because of the size of the project or the sensitivity of the water body, will need to choose an In Lieu Project in the same watershed, if feasible.

In Lieu Projects must be completed within two years of the completion of the qualifying new development or redevelopment project. If additional time is needed to complete the In Lieu Project, an extension may be requested and approved on a case-by-case basis. To compensate for long-term water quality and hydromodification impacts downstream of the project, penalties, in the form of additional fees or additional treatment areas, may be imposed on projects requiring time extensions by the jurisdictional agency.

Option 2 - In Lieu Fee

An In Lieu Fee may be paid toward the completion of a larger project from the pre-approved list. The amount of the In Lieu Fee will be calculated based on the treatment and/or volume capture not achieved on the project site, including maintenance costs, times a multiplier.

Chapter 5

BMP Inspection, Operation and Maintenance

Structural BMPs required for Regulated Projects must *meet manufacturers' or designer's recommendation for operation and maintenance* to ensure that the facilities are functioning as designed and do not create health and safety hazards.

To support these requirements, owners of Regulated Projects must provide specific operations and maintenance (O&M) related information with the SWQP during the project permitting process and submit annual self-certification reports documenting that the O&M activities are performed and BMPs are functioning properly.

5.1 Operation and Maintenance Submittal Requirements at the Permitting Stage

The following items are required to be included in the SWQP for all Regulated Projects:

- A signed statement from the project owner accepting responsibility for inspection and O&M activities for all structural BMPs at the project site until such responsibility is legally transferred to another entity.
- A signed statement from the project owner granting access to all representatives of the jurisdictional agency for the sole purpose of performing O&M inspections of the installed treatment systems(s), and hydromodification control(s) if any. Alternatively, this requirement is considered satisfied if an easement dedication or irrevocable offer of dedication is made to the jurisdictional agency providing equivalent access.
- A list of all structural BMPs on the project site and their specific inspection and O&M requirements. BMP-specific inspection and O&M requirements are included on the respective Fact Sheets (Appendix B). It is the responsibility of the project owner to review these requirements and develop a detailed site-specific O&M Plan to document these requirements and include it with the SWQP.
- A copy of any maintenance agreements that modify the BMP O&M responsibilities for the project.

5.2 Annual Self-Certification Reports

In addition to the above items, which are required at the permitting phase, Annual Self-Certification Reports must be submitted by the responsible party for the life of the project. In accordance with the Phase II MS4 Permit, the Annual Self-Certification Reports must include, at a minimum, the following information:

- Dates and findings of field observations to determine the effectiveness of the structural BMPs in removing pollutants of concern from storm water runoff and/or reducing hydromodification impacts as designed.
- Long-term plan for conducting regular maintenance of BMPs including the frequency of such maintenance.

Chapter 6

Developing a Post-Construction Storm Water Quality Plan (SWQP)

This chapter, in conjunction with the SWQP Template in Appendix A, provides project applicants, project owners, and design professionals with supplemental guidance for developing a SWQP for the various project categories defined herein.

The SWQP Template also provides planning and design review staff with a standardized submittal format to streamline the project review and approval process. In some cases, if the applicant wishes to propose alternative storm water control measures, supplemental documentation is required to be submitted to demonstrate equivalent performance per the listed criteria.

The SWQP for Regulated Projects must outline project compliance with the requirements of this Manual and include a signed certification statement by a registered professional engineer and project owner accepting responsibility for its development and implementation. SWQPs for Small Projects do not require a professional engineer's certification, however; some storm water control measures may require engineered designs. A copy of the Final SWQP shall be available at the project site for the duration of construction and then stored with the project approval documentation and improvement plans in perpetuity.

The SWQP development process begins with identifying the Project Category (see Chapter 2) and completing the corresponding sections in the SWQP template. Table 6-1 below lists the sections in the SWQP that must be completed for each Project Category.

Table 6-1 Required SWQP Sections by Project Category

Project Category	Required SWQP Sections
Small Projects	Sections 1 and 2
Regulated Projects, Regulated Redevelopment Projects, Regulated Road Projects, and Regulated LUPs	Sections 1, 3, 5 and 6
Regulated Hydromodification Management Projects	Sections 1, 3 through 6

For Small Projects, the project owner may prepare the SWQP. If the SWQP is prepared by the project owner, then the project owner takes the responsibility for ensuring the proper design of any storm water control measures that are included in the project. For Regulated Projects, a California licensed professional engineer is required to prepare, sign, and stamp the SWQP. Storm water control measures described in this Manual must be designed by, or under the supervision of, a qualified California licensed Professional Engineer with other specialist as may be needed.

Using the SWQP Template (Appendix A)

The SWQP Template is an automated Microsoft Excel-based tool that is provided in electronic format. The user proceeds through a series of pages by opening the workbook tabs which are labeled to indicate which form they contain. Required information is entered in the shaded gray cells, while other cells will self-populate, to complete the form. Each section below provides supporting information and guidance on completing the associated forms in the SWQP Template. Other more detailed reference information is provided in the preceding Chapters of this manual and in the BMP fact sheets in Appendix B.

Title Page

The title page identifies the project, project owner, and individual or consulting firm responsible for the preparation of the SWQP. It also lists the jurisdictional agency with approval authority for the project and responsibility for implementing the requirements of the Phase II MS4 Permit.

Project identification information such as Building or Grading Permit Numbers may vary among the jurisdictional agencies and should be included as appropriate for the specific project.

The SWQP preparation date is added by the preparer and the approval date is added by the approving jurisdictional agency to the cover as they become available.

Section 1 General Project Information

Section 1 documents basic information pertaining to the project and identifies the individual(s) responsible for the development and implementation of the SWQP. The Project Category is identified here.

There are two forms to be completed in Section 1 as follows:

Form 1-1 Project Identification and Owner's Certification

Form 1-1 supplements information provided on the title page with additional detail including the project address and a brief description of the project. For larger or more complex projects, sheets may be added to describe the project.

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The project owner's signature is required to certify responsibility for proper implementation of the SWQP. For Regulated Projects, the project owner signature also provides permission to access to all representatives of the jurisdictional agency for the sole purpose of performing O&M inspections of the installed treatment system(s) and hydromodification control(s), if any.

For Regulated Projects, a California licensed professional civil engineer is required to sign and stamp the SWQP. The professional engineer is responsible for designing all of the storm water control measures for the project site and developing the SWQP per the requirements set forth in the Phase II MS4 Permit and this Manual.

Form 1-2 Project Category

Form 1-2 identifies the project category. Determine the appropriate category by first quantifying the size of the newly created and/or replaced impervious surface and using the decision tree in Figure 2-3. Once the project category is determined, check the appropriate box on the form.

For redevelopment projects, determine the percent increase of impervious surface and check the appropriate box. The percent increase calculation must include both newly created and replaced surfaces.

Use the form to indicate if the project is a road or linear underground/overhead project (LUP) that creates 5,000 ft^2 or more of newly constructed contiguous impervious surface or is a public road project and/or falls under the building and planning authority of a jurisdictional agency.

After determining and checking the appropriate project category, enter the total new and/or replaced impervious surface area for the project.

Section 2 Requirements for Small Projects

Owners of Small Projects are required to complete the forms in Section 1 and 2 of the SWQP Template. The forms in Section 2 guide the development of the project layout, as discussed in Chapter 4, and incorporate one or more of the Site Design Measures listed in Table 4-1. Section 2 includes two forms to address these requirements.

Form 2-1 LID Site Assessment and Layout Documentation

The goal of the site assessment is to develop the site in a way that minimizes impacts to the site hydrology and other environmental functions and processes. The form lists a series of considerations that should be made when developing the layout. For each item, check the appropriate box to indicate that it has been considered and appropriately incorporated or that it is not applicable (N/A) and provide a brief explanation (use a separate sheet if necessary). To complete this form, develop and attach the site plan that illustrates the proposed site layout. The site plan may consist of a preliminary, or conceptual level design drawing, and it is a key requirement of the Preliminary SWQP described in Section 2.

Ensure that the following items, at a minimum, are included in the site plan:

- Site boundary
- Topographic data with one-foot contours (five foot contour intervals may be used for steeper sites)
- Existing natural hydrologic features (e.g., depressions, watercourses, wetlands, riparian corridors)
- Environmentally-sensitive areas and areas to be preserved
- Proposed locations and footprints of improvements creating new or replaced impervious surfaces
- Proposed site drainage with flow directions and site run-on and discharge locations
- Proposed Site Design Measures to reduce runoff

Form 2-2 Runoff Reduction Calculator Site Design Measures on Small Projects

This form is used to identify one or more Site Design Measures to implement on Small Projects and calculate the associated storm water runoff reduction. After identifying the Site Design Measure(s), enter the associated dimensions and quantity information into the form to calculate the storm water runoff reduction and effective treated impervious area. There is no minimum runoff reduction required for Small Projects. Design guidance for Site Design Measures is provided in the Fact Sheets in Appendix B. The equations, variables and units that are used to calculate the Site Design Measure volume reductions (V_r) are presented below for reference.

Adjacent/On-Site Stream Setbacks and Buffers

$$V_r = \left(\frac{1\,ft}{12\,in}\right) \times A_{imp} \times V_{85}$$

A_{imp} (ft^2) - Impervious drainage area discharging to the buffer
V_{85} (in) – Runoff volume from the 85th percentile, 24-hour design storm

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Soil Quality Improvement and Maintenance

$$V_r = (A_{pond} \times D_{pond}) + (A_{sa} \times D_{sa} \times \eta)$$

A_{pond} (ft^2) – Ponding area over soil improvement area
D_{pond} (ft) – Ponding depth over soil improvement area
A_{sa} (ft^2) – Surface area of improved soils
D_{sa} (ft) – Depth, or thickness, of improved soil layer
η - Porosity of amended soil

Tree Planting and Preservation

$$V_r = [(218 \times n_e) + (109 \times n_d) + A_{tc}] * V_{85} * \left(\frac{1\,ft}{12\,in}\right)$$

n_e – Number of new evergreen trees
n_d – Number of new deciduous trees
A_{tc} (ft^2) – A_{tc} (ft^2) – Canopy area of existing trees to remain on the property
V_{85} (in) – Runoff volume from the 85th percentile, 24-hour design storm

Rooftop and Impervious Area Disconnection

$$V_r = \left(\frac{1\,ft}{12\,in}\right) \times A_{imp} \times V_{85}$$

A_{imp} (ft^2) - Impervious rooftop or other area draining to pervious infiltration area
V_{85} (in) – Runoff volume from the 85th percentile, 24-hour design storm

Porous Pavement

$$V_r = A_{res} \times D_{res} \times \eta_{agg} \times C$$

A_{res} (ft^2) – Area of underlying gravel storage layer
D_{res} (ft) – Depth of underlying gravel storage layer
η_{agg} – Porosity of aggregate
C – Efficiency factor (See table in Fact Sheet SDM-5)

Vegetated Swales

$$V_r = \left(\frac{1\,ft}{12\,in}\right) \times A_{imp} \times V_{85}$$

A_{imp} (ft^2) - Impervious rooftop or other area draining to swale
V_{85} (in) – Runoff volume from the 85th percentile, 24-hour design storm